Space Weather Technical Forecast

Issued on Friday, 05 May 2023 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1-R2 blackouts expected throughout with a slight chance of R3 Strong radio blackouts. G1-G2/Minor-Moderate Storm conditions expected 7th and 8th May. Active electron fluence continuing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with a M3.9 flare at 04/0843UTC from AR3296 Dki/beta-gamma, although this region is not the largest or the most magnetically complex on the visible disc. In total there are eight number regions on the visible disc, with AR3293 the most magnetically complex, classified as Eki/beta-gamma-delta. The largest region on the disc is AR3297, but has a simpler magnetic structure and is currently classified as Eki/beta. The remaining five regions all relatively small, weak and magnetically simple.

Numerous CME's have departed from the Sun over the past 24 hours. Most of these appear far-sided. However, a full halo CME appears to be associated with the M3.9 flare, and therefore has an Earth directed component. Further analysis will be undertaken to determine if any of the other CME's leaving the Sun have Earth directed components.

Solar Wind / Geomagnetic Activity: The solar wind observed at L1 persisted at predominantly slightly elevated levels, peaking at 451 km/s at 04/0414 UTC. Density has mostly at average levels. Total magnetic field strength remained weak. The north-south component of the magnetic field has been weak, and generally negative. Phi angle was consistently negative (towards the Sun). Geomagnetic activity was Quiet throughout.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, has been at background levels throughout. High energy electron flux (greater than 2MeV) as measured at GOES16, has been at mainly High levels, peaking at 6983pfu at 04/1745UTC, but with brief dips to moderate levels between 04/0300UTC and 04/0700UTC. The 24-hour integrated fluence was at Active levels, with a gradually decreasing trend. At 05/0000 UTC 2.54e8 integrated pfu was recorded.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected with M-class flares, and a slight chance of X-class flares. Significant flares are most likely from AR3293, AR3296 and AR3297 in the northeast.

Solar Wind / Geomagnetic Activity: At present a CME, associated with the M3.9 flare on the 4th, is expected to arrive at Earth either late on day 3 (7th) or early on day 4 (8th). A connection to the HSS from coronal hole 99 is likely either later today or early tomorrow (5th or 6th), followed by a connection to a weaker HSS from coronal hole 01 on 06 May. Speeds are uncertain, but the combination of high speed streams could reach speeds of 450-500km/s.

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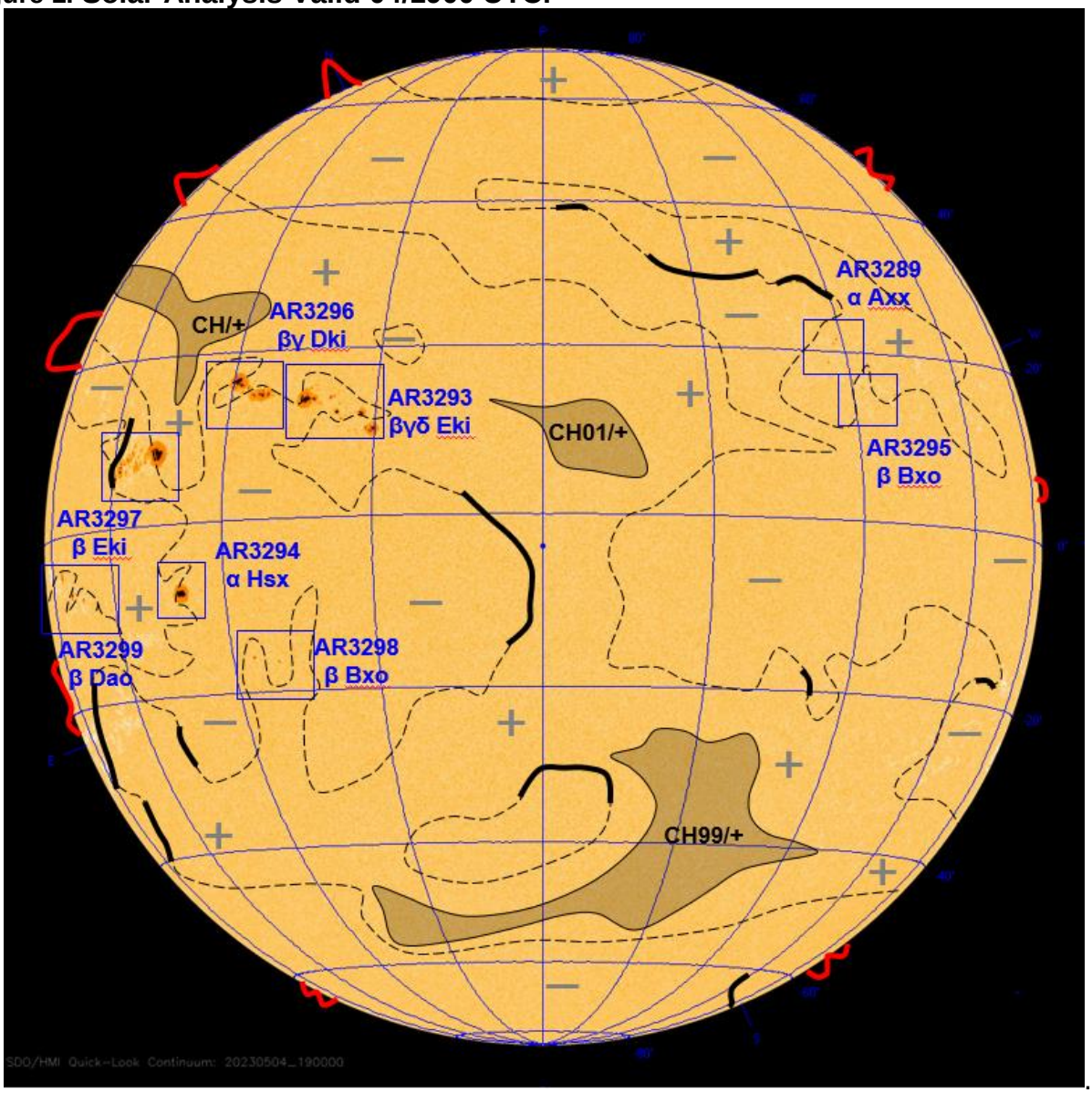
Geomagnetic activity is expected to be predominantly Quiet (Kp 1-2) today increasing Unsettled to Active (Kp 3-4) from late tomorrow (6th) or early on the 7th, with G1-G2/Minor-Moderate Storm (Kp 5-6) intervals likely late day 3 (7th) or early day 4 (8th) due to the expected CME.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is most likely to persist at background with no solar radiation storms occurring. High energy (greater than 2MeV) electron flux is expected to continue a diurnal oscillation, mainly above the High threshold, but with slightly declining peaks, until any geomagnetic storms occur. Geomagnetic storms are most likely either late day 3 (7th) or early day 4 (8th). Therefore by the end of the forecast period Background to Moderate high energy electron flux levels are expected. The corresponding electron fluence is expected to continue above the Active threshold (1e8 integrated flux), but with a declining trend, until late day 3 (7th) or early day 4 (8th), thereafter falling below the Active threshold.

Figure 1. Solar Analysis Valid 04/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

At present a CME, associated with the M3.9 flare on the 4th, is expected to arrive at Earth either late on day 3 (7th) or early on day 4 (8th). A connection to the HSS from coronal hole 99 is likely either later today or early tomorrow (5th or 6th), followed by a connection to a weaker HSS from coronal hole 01 on 06 May. Speeds are uncertain, as CH99 was not present on the previous rotation and on this current rotation CH01 is slightly small than before. However, the combined high speed stream could reach speeds of 450-500km/s.

Geomagnetic activity is expected to be predominantly Quiet (Kp 1-2) today increasing Unsettled to Active (Kp 3-4) from late tomorrow (6th) or early on the 7th, with G1-G2/Minor-Moderate Storm (Kp 5-6) intervals likely late day 3 (7th) or early day 4 (8th) due to the expected CME arrival. There is also a chance of a G1/Minor (Kp 5) geomagnetic storm occurring late tomorrow with the arrival of the CIR ahead of the HSS from CH99.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	30	70	60
Strong	G3	No	1	1	20	10
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1327	Full halo	M class from AR3296	NE	850 km/s	07/2300 UTC	Complex CME to analyse

Figure 2: Latest MOSWOC Enlil.

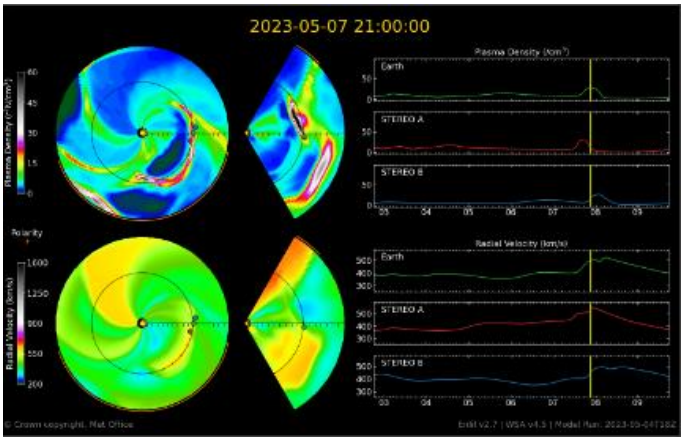

Figure 3: Latest MOSWOC Enlil ensemble.

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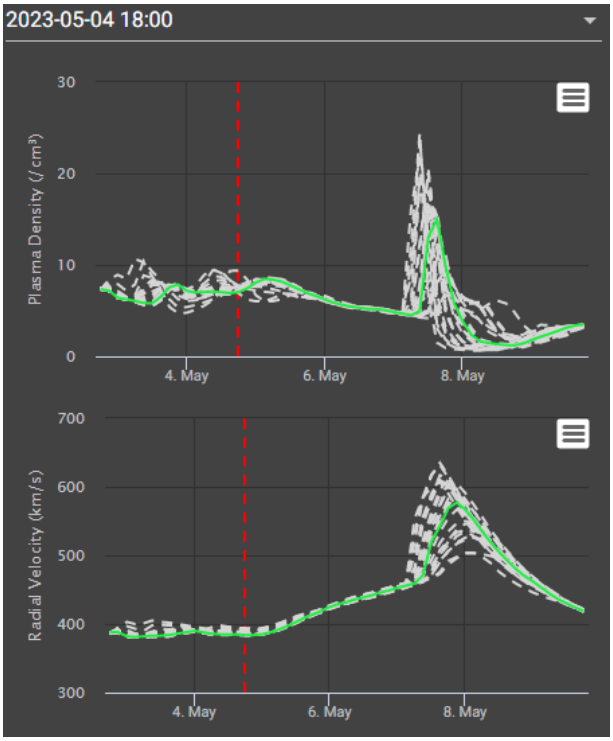

Radio Blackouts - X-Ray Flares:

There are currently eight sunspot regions on the visible disc, with AR3288 now rotated off onto the west limb, and with AR3299 recently numbered in the southeast quadrant. AR3293 is a large and magnetically complex region which has a small delta spot within an intermediate spot, and continues to show slight growth. AR3296, to the northeast of AR3293, also continues to grow, with recent small intermediate spots developing, but now currently appears to have a beta-gamma magnetic configuration. AR3297, to the southeast of the other main regions, appears large but perhaps not as magnetically complex as initially thought, now that it is becoming easier to analyse as it rotates further across the visible disc. The remaining regions are all smaller, weaker with little or no change.

Moderate activity is expected with M-class flares, and a slight chance of X-class flares. Significant flares are most likely from AR3293, AR3296 and AR3297 in the northeast.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	15	15	15	15

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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux as observed by GOES-16 is most likely to persist at background levels. However, count rates may increase with any significant flares that occur, mainly from AR3288 that has just reached the west limb. From tomorrow (6th) the risk of radiation storms diminishes slightly as AR3288 rotates further behind the west limb. Other regions in the east present an increasing, but as yet slight risk of Earth-directed radiation storms.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	15	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux is expected to continue a diurnal oscillation, mainly above the High threshold, but with slightly declining peaks, until any geomagnetic storms occur to distort the radiation belts. Geomagnetic storms are most likely either late day 3 (7th) or early day 4 (8th), with the arrival of a CME, although earlier there is a chance of geomagnetic storms with the arrival of two HSS from separate coronal hole features. Therefore by the end of the forecast period Background to Moderate high energy electron flux levels are expected.
The corresponding electron fluence is expected to continue above the Active threshold (1e8 integrated flux), but with a declining trend, until late day 3 (7th) or early day 4 (8th), thereafter falling below the Active threshold.

The latest MOSWOC REFM model is showing a declining trend over the next three days, which is accepted. However, the fluence is expected to remain above the Active threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	60	50
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: Latest MOSWOC REFM model.

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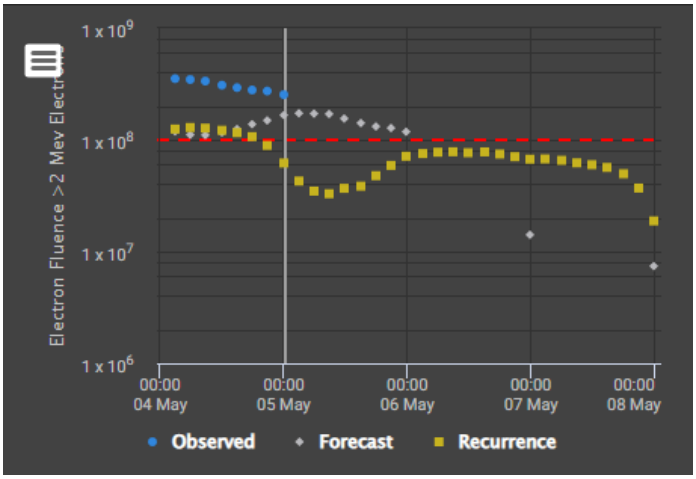

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